Bioremediation potential plants: use as heavy metal toxicity removal of industrial waste water

A Synopsis

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Introduction:-

The major concern of enviroment is gradual enhancement of pollution. The anthropogenic activites such as using of fertilizers and pesticides, deforestation, domestic waste, sewage, industrial effluents are main reason leading pollution at faster rate than natural disasters. These include degradable and non-degardable pollutants. Pollutant like heavy metals which is non biodegrable and is very hazardous to natural ecosystem as it accumulate into the food chain and can cause severe health issues. Remediation by the chemical methods are very costly and not worth with low metal toxicity areas. The term Bioremediation is "bio" means biological living being and "remediation" means correction or to solve a problem. Bioremediation of toxic heavy metals is another emerging method which is potentially advantageous over convential method as it is economical, eco friendly and effective.

The textile and garments industries in which the colour pigments in dying process is majorly responsible for the presence of heavy metal effluent in industry. An individual with heavy metal toxicity at low level can cause various symptoms such as weakness, headache, bodypain, redness in eyes etc. The presence of arsenic can cause cancer even at low level. In delhi NCR eight textile industries were examined for presence of heavy metal by Atomic Absorption spectrometry (Hitachi, Z-8100) (Bhardwaj *et al*., 2014).

There are number of negative responses can be seen in plants due to heavy metal toxicity such as tugor loss, decrease in growth and in roots, decrease in photosynthetic activity, leaf necrosis, apoptosis (Sharma and Dubey, 2007; Wang *et al*.,2018). The ion gated channels were also get distrubed due to heavy metal toxicity stress in plants (Demidchik, 2017).

There are several processes which is use by plants for remediating polluted sites. Phytovolatilization- it is the process in which plants use contaminants to modified it and release it into environment as volatile compound. The poplar tree is capable of extracting trichloroethylene and volatise it into environment (Burken and Schnoor,1999). Phytodegradation- plants and associated microbes degrade organic contaminants. Phytoextraction- plant extract contaminats and concentrate it in harvestable parts of plants. Phytostabilization- plant immobalise the pollutants into the environment. Rhizofiltration – plant use roots to remove heavy metals from stream.

Bioremediation can be done by employing microorganisms to breakdown contaminants by using them as food source, by algae, fungi's enzymes or by plants. Bioremediation with plants primarly need carefully selection of plant species such as poplar tree which remove toxic substances from contaminated areas by producing

extracellular enzymes that transform toxic substances into non-toxic and make more bioavalable it (Ancona V. *et al*., 2017).

While choosing microorganism and plants in bioremediation process number of factors taken in consideration such as organic and inorganic matter, pH balance, temprature, water holding capacity, density etc of polluted sites. The addition of suitable microorganisms along with plant in bioremediation process is more upgraded and efficient approach to make contaminated area free from heavy metal toxicity (chibuike and obiora, 2014).

Hyperaccumulator plants must have the capacity to uptake metal in larger quantity, faster root to shoot translocation , ability to grow faster and also reduce more than one heavy metal from the polluted sites. Nearby 500 plant speices are reported which have the capacity to reduce heavy metal toxicity. The brassicaceae plant speices(*brassica napus, brassica juncea, brassica rapa*) is most important hyperaccumulator plants (ebbs and kochian, 1997). The rate of bioremediation is directly proportional to plant growth rate and the total amount of bioremediation. Plants have the capabilites in themselves to remediate heavy metals from contaminated sites and do not spread it into the enviroment this technique is called as phytostabilization and this is best in in-situ bioremediation process (tak H.I. *et al*.,2013). .

The biremediator plants which are edible may lead to enter of heavy metals into the food web which can cause lethal impact on health. Because of this non edible plants such as aromatic and medicnal plants which gained interest as bioremediator plants (pirzadah et al.,2019). There are various families of aromatic plants such as *poaceae, asteraceae, geraniaceae and lamiaecae* found as very effective in bioremediation process. Aromatic plants are not directly consumed and are also used to make essential oil in which steam distillation process distilled heavy metal away (scora and chang, 1997).

For increasing the activity of remediation process in plants the genetic engineering is introduced in which plant genes are alterd by the help of vectors either by physical methods (electroporation ,high-velocity microprojectiles) or by biological means (using agrobacterium bacteria which insert selected DNA directly into plant chromosomes) and make them to synthesise specialised protein which later on selected in plant tissue culture for further breeding. The Zn tolerance is controlled in Zn-hyperaccumulator *Arabidopsis halleri* and less accumulator *Arabidopsis petrea* by a single major gene (McNair et al., 2000).

Review of literature:-

The hyperaccumulator plant having a capacity to provide protection against fungal and insect attack (chaney R.L et al., 1997). It is studied that heavy metal remediation by plants are done by biosorbents of cell wall such as peptidoglycan and polysaccharides which is an active binding site for higher metal uptake (Igiri et al., 2018). The phytoremediation of metals are done by two methods natural and induced which are use of hyper-accumulating plants and chemicals like synthetic chelating ligands respecively (Rahman M.A, 2016).

Sakakibara M *et al*.(2011) Studied the abilites of *Eleocharis acicularis* which is good hyperaccuumulator plant and capable of extracting copper,zinc, arsenic and cadmium from contaminated water bodies.

Cosio C *et al*.(2004) Investigated allocation of heavy metal in cells of hyperaccumulator plants *Thlaspi caerulescens* "Ganges" accumulate zn and cd in mesophyll protoplasts, *Arabidopsis halleri*, hyperaccumulators of zinc (Zn) and Cd and *T. caerulescens* "Prayon," accumulating Cd at a lower scale. There are more than one single transport system is used by *T. caerulescens* "Prayon" carrying Cd, in "Ganges," Cd may transported by other pathways and in *T. caerulescens* "Prayon," Cd transported by a Zn and Ca pathway.

kupper H. et al.(1998) studied that in in-situ detection of heavy metal in whole plant to check damaged mechanisms in it. For this they use fluorescence microscopy, absorbance spectroscopy. In result to this they observe heavy metal stress in some cells with abnormal fluorescence photosynthetic activity while some shows normal activity of same tissues.

Gisbert C. et al.(2003) The N glauca is Selected as bioremediator plant because they are easily available, fast growing and having high biomass. Scientist taken help of genetic engineering to transfer wheat gene encoding phytochelatin synthase (*TaPCS1)*by Agrobacterium which increased its tolerance to metals such as Pb and Cd.

Ali H. et al.(2012) Studied the capabilites of *T. alexandrinum* for bioaccumulating Zn, Pb, Cu, and Cd from pollucted site and their limitation is the translocation in roots and leaves is less which can be overcome by uprooting the plant.

Jadia .C and Fulekar M.H (2009) Studied about the various remediation concepts by using plants for cleaning contaminated sites of heavy metals which is environmental friendly and cost effective along with their case studies.

Dushenkov et al.(1995) studied about the ability of brassica juneca plant for the phytoremediation of heavy metal polluted water by using tissue absorbtion and root mediated precipitation methods.

Poschenrieder Ch. And Barceló J. (1999) Studied the relation between plant and water containing ion concentration. If the ranges of ion concentarion increases and listed from 0.1 to 1 M range there are number of adverse effects can be seen on plants.

Küpper .H et al.(1996) Studied about the submerged water plants with respect to heavy metal stress. The cental atom of chlorophyll that is magnesium is removed and substitued by heavy metal ion that adversely affect the photosynthetic activity of the plant. This reaction depends upon light intensity if light is high than chlorophyll is inaccessible to heavy metal ions.

Gill .M (2014) Describe about the increased accumulation of reactive oxygen species (ROS) and methylglyoxal (MG) which together can cause peroxidation of lipids, oxidation of protein, inactivation of enzymes, DNA damage under oxcidative stress conditions in plants.

li .J et al. (2015) They presents scientific basis for selection of water plants abilities under cd, zn and cu toxicity. The cability of a plant species to absorb particular metal is directly proportional with its ability to absorb the other metals from polluted sites.

Ebbs S.D and Kochian L.V(1998) studied an experiment in which they use oat, barley and Indian mustard abilities to accumulate zinc from znic contaminated soil conatning EDTA. This results that barely phytoremediation potential is similar and not greater than Indian mustard potential for remediation.

Bhaduri A.M. and fulekar M.H. (2011) Explains the effect of antioxcidant enzymes against heavy metal stress in plants which protects its cellular damage from reactive oxygen stress (ROS). This mechanism potentially increases the activity of phytoremediation.

kaur. R.(2018) The studies were made on non edible crop that is cotton plant which grown in punjab, india they were examine for bioaccumulation of heavy metals which results in value 1for bioaccumulation and translocation factor.

Ingole N.W and bhole A.G (2003) Studied the uptake of heavy metal using water hyacinth plant. They taken different concentration of water conating heavy metal from 5 mg/l to 50 mg/l and recorded its efficiency maxium in 5mg/l by the help of UV visible spectrophotometer.

Dixit S and Dhotle S (2009) Conducted experiment for the comparison between submerged macrophyte (*H. verticillata*) and free-floating macrophyte (*E. crassipes*) that which has better potential to purify water.

Jagetiya .B and kumar .S (2019) Heavy metal like Lead is non- biodegradable and persistence in the environment is one of the reason for pollution. They describes the remediation of lead by the help of plants and microbes.

Obejective:-

1) To collect the Sample of waste water from industrial effluent.
2) The analysis of Physiochemical properties and heavy metals.
3) To increase number of selected bioremediator plant.
4) To identify potential ability of bioremediator plant to remove contaminants.

Methodology:-

a. To collect the Sample of waste water from industrial effulent:-
   Selection of the projected sampling is done to satisfy the study of objectives. Sampling of wastewater will be collected from the industrial effluent from rajasthan. For this the sampling bottels are washed with deionized water and than they were filled with waste water contaning heavy metals. About 1000 ml of wastewater (500 ml for physicochemical and 500 ml for heavy metal analyses).

b. The analysis of Physiochemical properteis and heavy metals:-
   The selected wastewater sample is than analyzed to determine their physicochemical characteristics such as pH, acidity, biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), Phosphorus and Nitrogen. The heavy metals were determined by the atomic absorption spectrophotometer.

c. To increase number of selected bioremediator plant:-
   The selected plant grown in pot filled with black soil ,water and Hoagland solution for increasing their number under favourable conditions.

d. To identify potential ability of bioremediator plant to remove contaminants :-
   The plants is further transferred and grown in pure water as well as in wastewater conating flasks. The plant shoot, root and leaves of both the water are dried and mixed with distilled water to compare and analyse presence of heavy metal in each part of plant by atomic absorption spectrophotometer.

Work plan:-

S.NO.	Objectives	Time span
1	To collect the Sample of waste water from industrial effulent	Throughout year
2	Physiochemical and heavy metal analysis	Throughout year
3	To increase number of selected bioremediator plant	1 to 6 months
4	To identify potential ability of bioremediator plant to remove contaminat	6 to 12 months

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